Using rwm

A. I. McLeod
University of Western Ontario

Abstract

The **rwm** package provides an expedient approach to managing a large number of workspaces across multiple operating systems. In some situations, particularly with ephemeral projects, it provides an expedient alternative to using R libraries.

Keywords: Decision support systems, ephemeral computing, workspace, teaching.

---

1. Purpose

The **rmw** package is useful to R user's who has a large number of workspaces and/or works on ephemeral projects such as decision support, teaching, home work, etc. In many cases workspaces provide a more expedient and convenient way of sharing functions and data than using R packages. Simple documentation of the objects in the workspace is provided by using a variable `.Describe` that is displayed when the workspace is loaded or attached to.

This approach was loosely inspired by the way workspaces are handled in APL (Grenander 1982; Helzer 1989). The table below lists the functions included in **rwm** and their APL equivalents.

rwm Function	Description	APL Command
`loadws`	load workspace	*)LOAD*
`savews`	save workspace	*)SAVE*
`attachws`	attach workspace	*)LIB*
`cws`	save workspace and quit	*)CONTINUE*
`clearws`	clear workspace	*)CLEAR*

APL provides the command `)WSID` that can be used to find the name of the workspace. In **rwm**, the global variable `.WSID` provides the same functionality.

The functions provided in **rwm** may be used in interactive or batch mode with R and across all operating systems. In this way R scripts, accessing a variety of workspaces, may be made portable across all computer environments.

McLeod (2009) provides an overview of the **rwm** package with some other examples of its use.

2. Setup For rwm

You should always start R using the same workspace when using **rwm** since it needs to have the variables `.UserDirectory` and `.UserDate` defined. The **rwm** package organizes

your workspaces into subdirectories formed using `.UserDirectory`. The variable `.UserDate` specfies the subdirectories below `.UserDirectory` that contains current projects. For example on my Windows machine, `.UserDirectory` and `.UserDate` are set to `d:/r` and 2010 respectively. When I start R by clicking on the icon created when R was installed the workspace, `C:/Users/Ian/Documents/.Rdata`, is loaded. This workspace contains variables `.UserDirectory` and `.UserDate` that are described below.

Before using the package **rwm** an initial setup is needed to specify the location of your R projects. This setup is easily done after loading the package **rwm** and running the function `irwm`. Then use the R function `save.image` to save your starting workspace and then R. After restarting R, you are ready to use **rmw**.

Alternatively, you may simply do the initialization manually as discussed below of Windows, Mac and linux. More general ways of working with **rwm** are sometimes useful and are discussed in section 7.

2.1. Illustrative Setup For Windows

Start R in the usual way by clicking on the icon on your desktop or quick launch toolbar. In this script, I choose the directory for my R projects to be `d:/r` and my for my current works `d:/r/2010`. You should make any changes in the script below to reflect your preferences.

```
.UserDirectory <- "d:/r"
.UserDate <- 2010
save.image()
```

2.2. Illustrative Setup For Mac

Start R in the usual way by clicking on the icon in your applications folder or quickstart bar. In this script, I choose the directory for my R projects to be `/Volumes/MacAIM/R` and my for my current projects `/Volumes/MacAIM/R/2010`. You should make any changes in the script below to reflect your preferences.

```
.UserDirectory <- "/Volumes/MacAIM/R"
.UserDate <-  2010
save.image()
```

2.3. Illustrative Setup For Linux

Login to your account and start R in the usual way. In this script, I choose the directory for my R projects to be `users/faculty/aim/R` and my for my current works `users/faculty/aim/R/2010`. You should make any changes in the script below to reflect your preferences.

```
.UserDirectory <- "users/faculty/aim/R"
.UserDate <- 2010
save.image()
```

2.4. Generic Setup

For some purposes we need a directory assignment that is completely machine and OS independent. This is used for example in the Rd files in this package. The following initializes the setup variables for **rwm** and then saves the workspace.

```
R> .UserDirectory <- tempdir()
R> .UserDate <- "2010"
R> library(rwm)

Current directory: C:/Users/Ian/AppData/Local/Temp\Rtmp2oCWjh

R> save.image("GenericExample")
```

3. Using 'loadws' And 'savews'

3.1. Starting A New Project

The easiest way to start a new project is to use savews as in the following example.

```
> library(rwm)

Current directory: d:/r

R>  savews("diabetes/Table1")

d:/r/2010/diabetes/Table1 created!
working directory: d:/r/2010/diabetes/Table1
saved: d:/r/2010/diabetes/Table1/.Rdata
saved: d:/r/2010/diabetes/Table1/.RHistory
Fri Jul 02 17:54:20 2010
```

As indicated this creates a workspace with full pathname d:/r/2010/diabetes/Table1/.Rdata. The working directory has been set to d:/r/2010/diabetes/Table1. In addition, the R history to this point is saved. Finally the workpace variable .WSID now defined.

```
> .WSID

[1] "d:/r/2010/diabetes/Table1"
```

3.2. Recursive Directory Creation

In the above example, none of the subdirectories apart from d:/r need exist since the savews will create them as needed. This feature is illustrated in the following example:

```
R > savews("FirstContact", d=2063)
```

```
d:/r/2063 created!
d:/r/2063/FirstContact created!
working directory: d:/r/2064/FirstContact
saved: d:/r/2063/FirstContact/.Rdata
saved: d:/r/2063/FirstContact/.RHistory
Thu Jul 08 17:06:55 2010
```

When a directory is created recursively a message is given as in,

```
d:/r/2063 created!
d:/r/2063/FirstContact created!
```

3.3. Using The 'prefix' Argument

The default filename for a workspace is `.Rdata` but using the `prefix` argument available in `loadws`, `savews` and `attachws` allows workspaces to have names such as `prime.Rdata`, `459.Rdata`, `diabetes.Rdata`, etc. In this way many workspaces can be stored in a single subdirectory. The prefix used is stored in a global variable `.Prefix`. When the default workspace filename is used, `.Prefix` is undefined or set to the empty character.

```
R > clearws()
```

```
Workspace cleared.
Working directory: d:/r
```

```
R > lmLongley<-lm(Employed~., data=longley)
R > savews("459", prefix="longley")
```

```
d:/r/2010/459 created!
working directory: d:/r/2010/459
saved: d:/r/2010/459/longley.Rdata
saved: d:/r/2010/459/longley.RHistory
Mon Jul 12 17:49:28 2010
```

```
R > .WSID
```

```
[1] "d:/r/2010/459"
```

```
R > .Prefix
```

```
[1] "longley"
```

3.4. Full Pathnames

The primary purpose of `loadws` is to load a workspace that has previously been created using `savews`. But `loadws`, `savews` and `attachws` may also be used to load other workspaces as described in section 7.5.

4. Using attachws

4.1. A Teaching Example

For a simple example using `attachws` we create a 20-by-5 data matrix to be used by students in Stats 459. The workspace is saved as `Stats459/XMatrix`. We also make use of the `.Describe`-variable capability. After saving and clearing the workspace, it is attached to. In this example the R Workspace is used like a library or package.

```
R > library(rwm)

Current directory: d:/r

R >  savews("Stats459/XMatrix")

d:/r/2010/Stats459/XMatrix created!
working directory: d:/r/2010/Stats459/XMatrix
saved: d:/r/2010/Stats459/XMatrix/.Rdata
saved: d:/r/2010/Stats459/XMatrix/.RHistory
Mon Jul 12 16:05:42 2010

R > X<-matrix(rnorm(100), ncol=5)
R > .Describe<-"X is a 20-by-5 data matrix of NID(0,1) data"
R > savews()

working directory: d:/r/2010/Stats459/XMatrix
saved: d:/r/2010/Stats459/XMatrix/.Rdata
saved: d:/r/2010/Stats459/XMatrix/.RHistory
Mon Jul 12 16:07:12 2010

R > clearws()

Workspace cleared.
Working directory: d:/r

R > attachws("Stats459/Xmatrix")

attached:  d:/r/2010/Stats459/Xmatrix/.Rdata
.Describe = X is a 20-by-5 data matrix of NID(0,1) data
```

4.2. Using The 'prefix' Argument with 'attachws'

After running a long R simulation, we saved the data in the workspace `4.Rdata` on a unix computer. The prefix 4 signified that we use 10^4 simulations. We moved this file to our PC system in the subdirectory `d:/r/2010/AICa/Table1`, where we plan to carry out the statistical analysis and create the final tables for our report. We attach to this workspace

```
R > attachws("AICa/Table1", prefix=4)
```

```
attached:  d:/r/2010/AICa/Table1/4.Rdata
```

4.3. Using 'LibLocation' With 'attachws'

I also have many projects with LaTeXand I organize these projects in a similar fashion to the R projects. So LaTeXprojects are in subdirectories of `e:/tex/2009`, `e:/tex/2010`, etc. In some cases it is expedient to mix the project files. For example, if we are preparing a report, it may be convenient to put the necessary R files for producing tables and figures in a subdirectory of the report main directory.

For this reason, we may have preferred to copy `4.Rdata` to a subdirectory of the main directory where our report is being prepared. In this case the pathname for our subdirectory could be `e:/tex/2010/AIC/Tables/Table1` and we can attach to this directory with

```
R>  attachws("AIC/Tables/Table1", prefix="4",LibLocation="e:/tex")
```

```
attached:  e:/tex/2010/AIC/Tables/Table1/4.Rdata
```

5. Using 'clearws'

The function `clearws` removes all objects except `.UserDirectory` and `.UserDate` and changes the current working directory to the `IRWMD`. This is illustrated in the Windows example below,

```
R > clearws()
```

```
Workspace cleared.
Working directory: d:/r
```

Note that since `.WSID` is undefined in a clear workspace, some **rwm** functions won't work as illustrated with the continue function `cws` below:

```
R > cws()
```

```
Error in savews(silentQ = silentQ) : object '.WSID' not found
```

6. Using 'cws'

The `cws` simply saves the workspace and quits. It is assumed that the workspace has been previously saved using `savews` so that `.WSID` exists in the current workspace.

```
R > cws()
```

7. Working other directories

7.1. Initial R Workspace

In some case the R user may use subdirectories of the IWD for their R projects. But in many cases, it may be preferable to use some other directory. This may be necessary in multi-user environments or if the IWD is on a virtual drive.

For example, on my Windows PC, I used `d:/r` for all my R projects and all my current work for this year is in subdirectories of `d:/r/2010`. This subdirectory contains many further subdirectories which may be nested to any level. Each subdirectory may contain one or more R workspaces. The default filename for each workspace is `.Rdata` but prefixes such `tableA.Rdata` or `4.Rdata` may also be used.

The *installation directory* is where R and its component directories: `bin`, `library`, etc. are located. The location of this directory is often referred to as `R_HOME` and this location is typically stored by the OS in an environmental variable. When R is running the location `R_HOME` may be obtained using the function `R.home`:

```
R.home()
```

When R is started using the executable program located in the `bin` subdirectory of `R_HOME`, the default initial working directory (IWD) is used. The location of this default IWD may be determined using the R function `getwd`.

OS	Default IWD
Windows Vista	C:\Users\Ian\R
Mac OS X	/users/aim/R
linux	/users/faculty/aim/R

When the R workspace is saved using the function `save.image`, a workspace file with extension `.Rdata` is created in the current working directory,

```
save.image()
```

7.2. Initial rwm Workspace

When the package **rwm** is loaded using the R command `library(rwm)`, a script `.onLoad` is run which causes the current working directory to be set to the directory specified by `.UserDirectory`. This is illustrated in the brief example below:

```
R > library(rwm)
```

```
Current directory: d:/r
```

This workspace is usually nearly empty,

```
R > ls(all.names=TRUE)
```

```
[1] ".gW"                ".Random.seed"          ".UserDate"
[4] ".UserDirectory"     "SelectUserDirectory"
```

As in APL, I feel it is best to avoid confusion and leave `.WSID` undefined. It is defined when `loadws(...)` or `savews(...)` is used, where ... indicates that a non-null argument is given.

7.3. Working With Multiple IWDs

Sometimes when working with Mathematica or LaTeX, I find it convenient to save R workspaces along with these project files. This could be done by using the base R function *save.image* but it is easy to make an error in the pathname. So I find it convenient to use the function *SelectUserDirectory* to set up a different initial workspace. Of course, the user will likely need to modify the locations to suit their needs.

```
`SelectUserDirectory` <-
function(){
        cat("Select from the following:", fill=T)
        cat("1. d:/r", fill=T)
        cat("2. d:/math", fill=T)
        cat("3. e:/tex", fill=T)
        cat("4. R home", fill=T)
        ans <- as.numeric(readline("Enter your choice 1-4: \n >>:"))
        if (! (ans %in% 1:4)) ans<-4 #default, always valid
        .UserDirectory <<- switch(ans, "d:/r", "d:/math", "e:/tex", R.home())
        setwd(.UserDirectory)
        cat(paste("Current directory:", .UserDirectory), fill = TRUE)
}
```

Here I illustrate how this function works on one of my systems,

```
R >  SelectUserDirectory()
```

```
Select from the following:
1. d:/r
2. d:/math
3. e:/tex
4. R home
Enter your choice 1-4:
```

```
>>:3
```

```
Current directory: e:/tex
```

Workspaces can be loaded or save using `e:/tex` as the new initial rwm directory, as in the following example:

```
R > loadws("AIC/Tables")
```

```
working directory: e:/tex/2010/AIC/Tables
loaded: e:/tex/2010/AIC/Tables/.Rdata
loaded: e:/tex/2010/AIC/Tables/.RHistory
last saved: Thu Jul 08 15:18:01 2010
```

7.4. Using 'attachws' With 'LibLocation'

```
R > library(rwm)
```

```
Current directory: d:/r
```

```
R > attachws("AIC/Tables", LibLocation="e:/tex")
```

```
attached:  e:/tex/2010/AIC/Tables/.Rdata
```

An alternate year can be specified,

```
R > attachws("bicq/SAHeart", LibLocation="e:/tex", d=2009)
```

```
attached:  e:/tex/2010/AIC/Tables/.Rdata
```

In the above example, we could also load the workspace by specifying the full pathname,

```
R > attachws("e:/tex/bicq/SAHeart/.Rdata")
```

```
attached:  e:/tex/2009/bicq/SAHeart/.Rdata
```

More examples of working with full pathnames are shown in the next section.

7.5. Using Full Pathnames

The functions `loadws`, and `attach` may use the argument `name` to directly specify a full pathname for the workspace.

Example Using 'loadws'

In this example we load a workspace by using the full pathname `e:/temp/.Rdata` Then we use `attachws` to add a workspace with some data to our R search path. Notice that the current working directory is `e:/temp/` and the save workspace function works correctly even in this non-standard location.

```
R>  loadws("e:/temp/.Rdata")


working directory: e:/temp
loaded: e:/temp/.Rdata
loaded: e:/temp/.RHistory
last saved: Tue Jul 06 18:12:19 2010


attachws("AICa/Table1", prefix=4)


attached:  d:/r/2010/AICa/Table1/4.Rdata


R > search()


 [1] ".GlobalEnv"                       "file:d:/r/2010/AICa/Table1/4.Rdata"
 [3] "package:RWinEdt"                  "package:rwm"
 [5] "package:stats"                    "package:graphics"
 [7] "package:grDevices"                "package:utils"
 [9] "package:datasets"                 "package:methods"
[11] "Autoloads"                        "package:base"


R > savews()


working directory: e:/temp
saved: e:/temp/.Rdata
saved: e:/temp/.RHistory
Wed Jul 07 12:13:17 2010


R > getwd()


[1] "e:/temp"


R >  .WSID


[1] "e:/temp"
```

Full Pathnames Using 'save.image'

The full-pathname capability is not directly provided with `savews`. Instead the following approach is suggested. To save a workspace in another location simply use the built-in R function `save.image` and then load it using `loadws` as in the following example,

```
R > library(rwm)


Current directory: d:/r
```

```
R > save.image("C:\\Temp\\.RData")
R > loadws("c:/temp/.Rdata")

working directory: c:/temp
loaded: c:/temp/.Rdata
```

Using `loadws` defines .WSID,

```
R > .WSID
```

```
[1] "c:/temp"
```

Alternatively `attachws` could be used in this example if it was desired to emulate an R workspace.

Graceful Exit

The functions `loadws`, `savews` and `attachws` stop gracefully if the argument `name` is not valid. In the first example below, `d:/r/2010/1024` is a valid pathname but the full pathname for the workspace is needed.

```
R > loadws("d:/r/2010/1024")
```

```
Error in loadws("d:/r/2010/1024") :
  d:/r/2010/1024: Workspace is not valid or does not exist.
```

Since `d:/r/2010/1024/.Rdata` is a valid workspace it loads fine using the full pathname.

```
R > loadws("d:/r/2010/1024/.Rdata")
```

```
working directory: d:/r/2010/1024
loaded: d:/r/2010/1024/.Rdata
loaded: d:/r/2010/1024/.RHistory
last saved: Wed Jan 06 11:19:29 2010
```

In the example below, `d:/r/2010/9999` does not exist. So the function `loadws` tries to interpret it using the default directory structure and it fails with a slightly less direct message.

```
R > loadws("d:/r/2010/9999")
```

```
 Error in loadws("d:/r/2010/9999") :
  d:/r/2010/d:/r/2010/9999 does not exist.
```

8. Namespace

The **rwm** package using the namespace mechanism to ensure reliability and efficiency (Chambers 2008, §4.5). When **rmw** is attached using the `library` command, the `.onLoad` function shown below is run.

```
R > .onLoad

function (libname, pkgname)
{
    if (testrwm()) {
        setwd(.UserDirectory)
        cat(paste("Current directory:", .UserDirectory), fill = TRUE)
    }
    else cat("Please run `rwmInit()`.",
        fill = TRUE)
}
```

9. Maintenance Issues

Ever year you will need to add a new directory and update the variable `.UserDate`.

10. FAQ

In this section I will attempt to address difficulties that may be encountered using **rwm**.

10.1. Starting R by clicking on the workspace

A common way of starting R in a Gui environment is to click on the workspace file that is located in the directory containing the current project files. If this workspace was saved using `savews`, there is no problem. Otherwise you will need to define the variables `.UserDirectory` and `.UserDate`.

10.2. Multiple workspaces in one directory

The usual default workspace is `.Rdata` which is usually treated as a hidden or system file. But other valid workspaces may be obtained by prepending a valid filename. In the example below we save three workspaces in the same directory,

```
R > savews("2063/FirstContact")

d:/r/2010/2063/FirstContact created!
working directory: d:/r/2010/2063/FirstContact
saved: d:/r/2010/2063/FirstContact/.Rdata
saved: d:/r/2010/2063/FirstContact/.RHistory
Fri Jul 09 18:44:36 2010

R > savews("2063/FirstContact", prefix="Borg")

working directory: d:/r/2010/2063/FirstContact
saved: d:/r/2010/2063/FirstContact/Borg.Rdata
saved: d:/r/2010/2063/FirstContact/Borg.RHistory
Fri Jul 09 18:44:56 2010
```

```
R >  savews("2063/FirstContact", prefix=15)
```

```
working directory: d:/r/2010/2063/FirstContact
saved: d:/r/2010/2063/FirstContact/15.Rdata
saved: d:/r/2010/2063/FirstContact/15.RHistory
Fri Jul 09 18:48:10 2010
```

Our current working directory is,

```
R >  getwd()
```

```
[1] "d:/r/2010/2063/FirstContact"
```

and it contains the files,

```
R > list.files(all.files=TRUE)
```

```
[1] "."            ".."           ".Rdata"        ".RHistory"
[5] "15.Rdata"     "15.RHistory"  "Borg.Rdata"    "Borg.RHistory"
```

References

Chambers JM (2008). *Software for Data Analysis: Programming with R*. Statistics and Computing. Springer-Verlag.

Grenander U (1982). *Mathematical Experiments on the Computer*, volume 105 of *Pure and Applied Mathematics*. Academic Press, New York. ISBN 0-12-301750-5.

Helzer G (1989). *An Encyclopedia of APL*. I-APL Ltd, 2 Blenheim Road, St Albans, Hertfordshire AL1 4NR, 2 edition. ISBN 1 871020 05 0. Free International APL Project.

McLeod AI (2009). "rwm: An R Package for Workspace Management." *The R Journal*. Submitted.

Affiliation:

A.I. McLeod
University of Western Ontario
E-mail: aimcleod@uwo.ca